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Bibliography of Selected Reports on Electron Microscopy and Its Use in Monitoring Asbestos

Tracor Jitco, Inc.
Rockville, MD

Prepared for

Environmental Protection Agency
Washington, DC

Jun 80

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Bibliography of Selected Reports on Electron Microscopy and Its Use in Monitoring Asbestos.

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M. Virginia Shreve.

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Office of Pesticides and Toxic Substances.
EPA-560/1380-019
Final rept. 1 Jan 68-1 Jun 80

Presented at the Asbestos International Asociation's (3rd) Colloquim on Dust Measuring Techniques and Strategy Held at Cannes, France on June 10-12, 1980.

A bibliography of selected documents and reports issued by the U.S. Environmental Protection Agency on electron microscopy has been assembled as a quick reference document; several additional reports from other government agencies are also included. This document also includes summaries of electron microscopy studies currently sponsored by the U.S. Environmental Protection Agency. It was prepared for international distribution at the Asbestos International Association's Third Colloquium on Dust Measuring Techniques and Strategy held in Cannes, France, June 10-12, 1980.

KEYWORDS: *Bibliographies, *Asbestos, *Electron microscopy, *Environmental surveys.

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UNITED STATES
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OFFICE OF PESTICIDES
AND TOXIC SUBSTANCES

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BIBLIOGRAPHY OF SELECTED REPORTS ON ELECTRON MICROSCOPY AND ITS USE IN MONITORING ASBESTOS

JUNE 1980

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CURRENT ELECTRON MICROSCOPY STUDIES
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16. ABSTRACT

A bibliography of selected documents and reports issued by the U.S. Environmental Protection Agency on electron microscopy has been assembled as a quick reference document; several additional reports from other government agencies are also included. This document also includes summaries of electron microscopy studies currently sponsored by the U.S. Environmental Protection Agency. It was prepared for international distribution at the Asbestos International Association's Third Colloquium on Dust Measuring Techniques and Strategy held in Cannes. France, June 10 - 12, 1980.

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JUNE 1980

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDES AND TOXIC SUBSTANCES
OFFICE OF PROGRAM INTEGRATION AND INFORMATION
WASHINGTON, D.C.

Prepared by

TRACOR JITCO, INC.
ROCKVILLE, MD

Contract 68-01-6021

EPA Project Officer: Gerry Brown

Tracor Jitco Project Manager: Regina Origoni

Compiler, Editor: M. Virginia Shreve

INTRODUCTION

The U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, Office of Program Integration and Information (OPII) encourages international cooperation on the measurement and control of toxic chemicals. OPII supports the efforts of the Asbestos International Association to develop and standardize occupational and non-occupational monitoring protocols for asbestos.

The Association's Third Colloquium on Dust Measuring Techniques and Strategy - Cannes, France, June 10-12, 1980 will address non-occupational exposure to asbestos and will serve as a forum to document the state-of-the-art in electron microsocopy, circa 1980. The Colloquium will allow the participants to exchange ideas and perceptions on the various problems associated with asbestos measurements and will provide a backdrop against which the participants may gauge their own research progress in the coming years.

To assist the participants in placing Cannes and June 1980 into perspective, a bibliography of selected documents and reports issued by the U.S. Environmental Protection Agency on electron microscopy has been assembled as a quick reference document; several additional reports from other government agencies are also included. The reports selected are considered those most relevant to the agenda of the Colloquium. They are alphabetized by principal author or investigator.

The Office of Program Integration and Information extends best wishes to the Association for continued success with its series of International Colloquiums on Dust Measuring Techniques and Strategy.

Anderson, C.H (Investigator)
Electron Microscopy
Sponsoring Organization:
Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Athens, Georgia
Contract/Grant No.: K713B-127

This project will develop an analytical method, based on best current technology, for determining the asbestos fiber content and size distribution in water. After developing and publishing an interim method, new and improved techniques will be established. Methods will be developed for physical and chemical characterization of particulates.

Results to Date:
An interim asbestos method, based upon state-of-the-art, was published after applying this method on a variety of different water sources. It has been established that improvements are possible and therefore result in an improved procedure.

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Feldman, R. (Investigator)
Preparation of Suspension of Asbestos in Water Suitable for Use as Reference Samples for Electron Microscopy
Sponsoring Organization:
Water Supply Research Division
Municipal Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio
Contract/Grant No.: C614A-7167

This study involves preparation of asbestos suspensions utilizing various asbestos sources to determine the feasibility of their use as reference samples. During the initial phase of this project, a known mass of asbestos will be suspended in a detergent solution containing $HgCl_2$ preservative. The characteristics of asbestos from at least two sources (synthetic asbestos being prepared under contract, and asbestos being used by NIEHS in animal feeding studies) will be examined to determine which source provides asbestos with the desired characteristics. This asbestos suspension must contain fibers which (1) can be analyzed by electron diffraction and energy dispersive x-ray fluorescence, (2) have a size distribution like that usually found in water supplies, (3) does not clump and appears in preparations as individual fibriles, and (4) contains little foreign material. If satisfactory suspensions can be prepared, they will be sorted in 20 ml sealed ampoules and periodically analyzed to determine if the suspension changes with time. If no significant changes occur in 6 months, then reference samples will be prepared for distribution.

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Anderson, C.H.; Long, J.M.
Interim Method for Determining Asbestos in Water
Sponsoring Organization:
Analytical Chemistry Branch
Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Athens, Georgia
EPA-600/4-80-005, 44 p. January 1980

Scope and Application:
This method is applicable to drinking water and water supplies.

The method determines the number of asbestos fibers per liter, the size (length and width) of the fibers, the size distribution, and the total mass. The method distinguishes chrysotile from amphibole asbestos. The detection limits are variable and depend upon the amount of total extraneous particulate matter in the sample as well as the contamination level in the laboratory environment. Under favorable circumstances, 0.01 million fibers per liter (MFL) can be detected. The detection limit for total mass of asbestos fibers is also variable and depends upon the fiber size and size distribution in addition to the factors affecting the total fiber count. The detection limit under favorable conditions is in the order of 0.1 nanogram per liter (ng/L).

The method is not intended to furnish a complete characterization of all the fibers in water.

It is beyond the scope of this method to furnish detailed instruction in electron microscopy, electron diffraction, or crystallography. It is assumed that those using this method will be sufficiently knowledgeable in these fields to understand the methodology involved.

Summary of Method:
A variable, known volume of water sample is filtered through a 0.1 micrometer (μm) Nuclepore filter to trap asbestos fibers and the filter is then carbon coated. A small portion of the carbon coated filter with deposited fibers is placed on an electron microscope grid and the filter material is removed by gentle solution in organic solvent. The material remaining on the electron microscope grid is examined in a transmission microscope at a magnification of about 20,000X. The asbestos fibers are identified by their morphology and electron diffraction patterns and their lengths and widths are measured. The total area examined in the electron microscope is determined and the number of asbestos fibers in this area is counted. The concentration in MFL is calculated from the number of fibers counted, the amount of water filtered, and the ratio of the total filtered area/sampled filter area. The mass per liter is calculated from the assumed density and the volume of the fibers.
(from Text)

Chatfield, E.J.; Glass, R.W.

Preparation of Water Samples for Asbestos Fiber Counting by Electron Microscopy

Sponsoring Organization:

Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Athens, Georgia

EPA-600/4-78-011, (NTIS #PB-280 183/5BE) 118 p. 1978

Procedures used by a number of laboratories for the analysis of asbestos fibers in water samples were investigated using standardized aqueous dispersions of chrysotile, crocidolite, and taconite tailings. Filtration problems when using polycarbonate filters were solved, and an optimum filtration technique was developed that permits microscopically uniform deposits to be obtained. Replicate analyses established fiber losses and reproducibility of five filter preparation techniques. The uniformity of the deposits on all the final electron microscope preparations was expressed quantitatively, and the most satisfactory performance was given by all of the Nuclepore techniques. Ultrasonic treatment at 20 kHz increased fiber concentrations of chrysotile suspensions but had no effect on crocidolite suspensions.

Cook, P.M.; Smith, P.L.; Wilson, D.G.

Amphibole Fiber Concentration Determination for a Series of Community Air Samples: Use of X-Ray Diffraction to Supplement Electron Microscope Analysis

Sponsoring Organization:
Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Duluth, Minnesota
EPA-600/J-78-059, (NTIS #PB-289 183/6ST) 15 p. 1978

The accurate measurement of annual average mineral fiber concentrations at various air sampling sites provides the best index of non-occupational inhalation exposure to fibers in a community located near an industrial source of airborne amphibole fibers. The transmission electron microscope analysis of enough individual high volume air samples to provide annual average fiber concentrations is not feasible because of the great time and expense required. X-ray diffraction analysis of air samples collected on membrane filters over periods of several days offers a reliable measurement of amphibole mineral mass concentration. An excellent linear correlation ($r=0.94$ for $N=12$) exists between the amphibole mass concentrations (x-ray diffraction) and amphibole fiber concentrations (transmission electron microscope). The correlation equation is used to calculate amphibole fiber concentrations from over 300 x-ray diffraction analyses. The accuracy and precision of both techniques are discussed as well as particle concentration variations influenced by meteorology, emission sources, and sampling location.

Gerber, R.M.; Rossi, R.C.

Evaluation of Electron Microscopy for Process Control in the Asbestos Industry

Performing Organization:
Aerospace Corporation
Los Angeles, California
Sponsoring Organization:
Industrial Environmental Research Laboratory
Office of Research and Development
U.S.Environmental Protection Agency
Research Triangle Park, North Carolina
EPA-600/2-77-059, (NTIS #PB-266 091/8ST) 55 p. 1977

The report gives results of an evaluation of the transmission electron microscope (TEM) and the scanning electron microscope (SEM) as potential tools for fine particle asbestos counting for process control in the asbestos industry. The study defined the capabilities and limitations of the instruments in applications where asbestos specificity is not necessarily required, and where analysis cost must be minimal. The study showed that the microscopes are equally capable of counting all fibers in the full particle size distribution; but, for reasons of agglomeration and confusion with the filter texture, each microscope can observe only 75% of the distribution. In contrast, present standard light microscopy methods observe only the coarser 10% of the distribution, without resolving the fine fibers. Optimum asbestos fiber counting was done at 15,000 times magnification and at fiber concentrations on the filter between 40,000 and 80,000 fibers per sq. mm. The minimum number of fibers counted to obtain high statistical confidence was 200 fibers per datum point. Standard techniques for filter sample preparation were found to have no effect for either instrument. Ashing of filters to remove non-asbestos fibers was responsible for 85% asbestos fiber loss.

Hesse, C.S.

Investigation of Rainwater for the Presence of Asbestos

Performing Organization:
Master's Thesis
Illinois University Medical Center
Chicago, Illinois
Sponsoring Organization:
Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C.
OWRT-A-071-ILL (4), (NTIS #PB-288 084/7ST) 55 p. 1977

A feasibility study was undertaken in order to determine if chrysotile asbestos is present in rainwater. Rainwater samples were collected at one Chicago and two suburban Chicago locations. The Chicago location was near a busy intersection and building construction. The two suburban stations were located in residential areas. None of the suburban rainwater samples contained levels of chrysotile which were significantly above laboratory contamination levels (alpha=.05). All the Chicago rainwater samples contained significant levels of chrysotile. This finding suggests a mechanism by which asbestos may be transferred from air to surface water.

Melton, C.W.; Anderson, S.J.; Dye, C.F.; Chase, W.E.;
Heffelfinger, R.E.

Development of a Rapid Analytical Method for Determining Asbestos in Water

Performing Organization:
Battelle Columbus Labs
Columbus, Ohio
Sponsoring Organization:
Environmental Research Laboratory
U.S. Environmental Protection Agency
Athens, Georgia
EPA-600/4-78-066, (NTIS #PB-290 687/3ST) 80 p. 1978

The development of a rapid analytical method for determining chrysotile asbestos in water that requires substantially less time per analysis than electron microscopy methods is described. Based on the proposition that separation of chrysotile from other waterborne particulate would greatly simplify the task of detection, the research effort was directed toward establishing separation and concentration techniques. This investigation led to the development of a separation procedure whereby chrysotile is extracted from a water sample into an immiscible organic liquid phase. The procedure is called two-phase liquid separation (TPLS). TPLS has been combined with a light microscopic intercept counting technique and with a colorimetric spot test detection technique to result in two complete rapid analytical methods. The TPLS-light microscopic (LM) method requires more expensive equipment than the TPLS-spot test method; however, the limit of detection of TPLS-LM method is 1.0 ng at the 99 percent confidence level, whereas the limit of detection of the TPLS-spot test method is approximately 100 ng. The TPLS-LM method, therefore, is recommended as a first choice, and the TPLS-spot test method is recommended for use under conditions that require no greater detection sensitivity than 100 ng per sample. Experiments have shown that 75 percent of the chrysotile is extracted by TPLS.

Miller, J.L. (Investigator)
Morphology and Composition of Particulates Emitted by Mobile Sources
Sponsoring Organization:
Special Techniques Group
Emissions Measurements and Characterization Division
Environmental Sciences Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina
Contract/Grant No.: G712B-BC-06

Objectives:
Determine the morphology and elemental composition of particulate matter emitted by mobile sources using electron-optical techniques.

Approach:
The analyses will be carried out using transmission and scanning electron microscopy, electron microprobe measurements, and advanced image analysis techniques.

Current Plans/Progress:
Particulate sources currently under study include automobile brake linings and diesel engines, and specific items being studied include lead and asbestos samples.

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Millette, J.R. (Investigator)
Assessment of Asbestos Exposure to U.S. Public from Drinking Water
Sponsoring Organization:
Health Effects Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio
Contract/Grant No.: D614B-018D

The purpose of this task is to gather information either by in-house analyses of correspondence with other researchers or the extent of asbestos fiber in the drinking waters of the United States.

The output of this task will be an ORD Research Report which will list the asbestos data compiled by water supply and state and classified as to analyzing laboratory and type of analysis method used.

Results to date include in-house analyses of nearly 500 samples and compilation of data on over 700 water supplies in 32 states.

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Millette, J.R. (Investigator)
Electron Microscope Analysis of Fibers in Tissue - Support to Migration Studies
Sponsoring Organization:
Health Effects Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio
Contract/Grant No.: D614B-010D

The purpose of this task is to provide support for synthetic tritiated asbestos studies of migration of asbestos fibers in the tissues of mammals.

The outputs of the task will be in-house reports which will eventually be data listed in EPA publications of the research on asbestos migration in the body.

No results are available to date because the synthetic asbestos to be used in the studies has not been produced.

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Millette, J.R. (Investigator)
Identification of Non-asbestos Fibers Ocurring in Drinking Water
Sponsoring Organization:
Health Effects Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio
Contract/Grant No.: D614B-101

The purpose of this task is to provide data and non-asbestos fibers in drinking water through electron microscopy analyses.

The output of this task will be a report on the particulates in drinking water.

Results to date include analyses of over 100 samples for particulates. The only non-asbestos fibers found in significant concentrations have been biological in origin, and clays.

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Millette, J.R. (Investigator)
Particulate Analysis of Drinking Water Supplies
Sponsoring Organization:
Exposure Evaluation Branch
Field Studies Division
Health Effects Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio
Contract/Grant No.: D614B-007C

The purpose of this task is to accumulate data on the particulates found in drinking water and develop systems for classification of these particulates.

The outputs of this research will be in-house reports on particulates found in various water samples and the preparation of an ORD Research Report on particulates in drinking water.

Results to date include analysis of over 60 samples of drinking water and classification of particulates into fibrous, non-fibrous, crystalline, organic and asbestos categories. A report differentiating between chrysotile asbestos and two clays, attapulgite and halloysite, is being prepared.

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Millette, J.R.
"Monitoring Drinking Water for Asbestos by Transmission Electron Microscopy"
Sponsoring Organization:
Health Effects Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, Ohio
Symposium on the Electron Microscopy of Microfibers,
U.S. Department of Health, Education and Welfare Publication:
FDA-77-1033, p.85-92 1977

Abstract not available.

Mueller, P.K.; Alcocer, A.E.; Stanley, R.L.; Smith, G.R.

Asbestos Fiber Atlas

Performing Organization:
Air and Industrial Hygiene Laboratory
California State Department of Health
Berkeley, California
Sponsoring Organization:
Chemistry and Physics Laboratory
National Environmental Research Center
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina
EPA-650/2-75-036, (NTIS #PB-244 766/2ST) 58 p. 1975

Transmission electron micrographs and corresponding selected area electron diffraction patterns of standard specimens of serpentine and amphibole asbestos are presented for use by analysts as an aid in identification. Micrographs and diffraction patterns of typical ambient air samples and of certain minerals that often occur with airborne asbestos are included also. Specimens were uniformly prepared and examined in a single electron microscope.

Pattnaik, A.; Meakin, J.D.

Development of Scanning Electron Microscopy for Measurement of Airborne Asbestos Concentrations

Performing Organization:
Franklin Institute Research Laboratories
Philadelphia, Pennsylvania
Sponsoring Organization:
Chemistry and Physics Laboratory
National Environmental Research Center
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina
EPA-650/2-75-029, (NTIS #PB-279 517/5ST) 90 p. 1975

The methodology that was developed at the Franklin Institute Research Laboratories (FIRL) under the EPA Contract No. 68-02-0544, for the determination of airborne asbestos has been perfected and developed further. Moreover, the newly perfected technique has been applied to point source, near the analytical method which employs a scanning electron microscope equipped with energy dispersive x-ray analysis for the identification and counting of airborne asbestos. The specimens, prepared in a unique manner, are suitable for image analysis and for a possible automated counting system. Results of the analysis on airborne asbestos are presented, and limitations and advantages of the present techniques are discussed.

Russell, P.A.; Hutchings, A.E.
Electron Microscopy and X-ray Applications to Environmental and Occupational Health Analysis
(book) 278 p. 1978

The proceedings of a symposium discuss and evaluate applications of X-ray fluorescence, X-ray diffraction, scanning electron microscopy and transmission electron microscopy analysis to analytical problems encountered in the environmental and occupational health fields. The 24 papers discuss topics such as the use of X-ray fluorescence in the analysis of filter-collected aerosol particles, atmospheric particulate samples for Pb, respiratory dust in lung tissue and on membrane filters and multielement analysis of urine; the use of X-ray diffraction in quantitative analysis of air particulates, S distribution studies of coals and air samples, determination of amphibole concentration in air samples and analysis for impurities in talc powders; the use of EM in the identification of asbestos and particulates, in analysis of amphibole mineral fiber and atmospheric S-contaning particles, quantitative analysis of individual microparticles and in a study of plume aerosols from a coal-fired power plant. Charts, tables, graphs, micrographs and a subject index complement the text. Appropriate papers are indexed in BioResearch Index.

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Samudra, A.V.; Harwood, C.F.; Stockham, J.D.
Electron Microscope Measurement of Airborne Asbestos Concentrations - A Provisional Methodology Manual
Performing Organization:
IIT Research Institute
Chicago, Illinois
Sponsoring Organization:
Environmental Sciences Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina
EPA-600/2-77-178, (NTIS #PB-276 481/9ST) 58 p. 1977

This manual describes a provisional optimum electron microscope (EM) procedure for measuring the concentration of asbestos in air samples. The main features of the method include depositing an air sample on a polycarbonate membrane filter, examining an EM grid specimen in a transmission electron microscope (TEM), and verifying fiber identity by selected area electron diffraction (SAED). This provisional manual results from a study to develop an optimum EM procedure for airborne asbestos determination. The analytical data supporting the provisional methodology are included in a separate final report.

Provisional Methodology - Summary:

Take an air sample on a polycarbonate membrane filter, 0.4 um, using a high-volume or personal sampler.

Coat the filter with a 40 nm thick film of carbon using a vacuum evaporator.

Transfer the deposit from the polycarbonate filter to an electron microscope grid using a modified Jaffe washer. The Jaffe washer is prepared as follows. A 60 or 100 mesh stainless steel mesh is placed on top of a paper filter stack or foam sponge contained in a petri dish. Chloroform is carefully poured into the petri dish until the level is just touching the stainless steel mesh. A 1 mm x 2 mm portion of carbon coated polycarbonate filter is placed particle side down on a 200 mesh carbon coated copper electron microscope (EM) grid and this pair is placed on the steel mesh. The 1 mm x 2 mm portion is wetted with a 5 ul drop of chloroform. The polycarbonate filter will dissolve in about 24 to 48 hours.

Examine the EM grid under low magnification in the TEM to determine its suitability for high-magnification examination. Ascertain that the loading is suitable and is uniform, that a high number of grid openings have their carbon film intact, and that the sample is not contaminated.

Samudra, A. V.; Harwood, C. F.; Stockham, J. D. (cont.)

Systematically scan the EM grid at a magnification of about 20,000X(screen magnification 16,000X) for chrysotile and possibly a lower magnification for cases where predominant amphibole fibers are present. Record the length and breadth of all fibers that have an aspect ratio of greater than 3:1 and have substantially parallel sides. Observe the morphology of each fiber through the 10X binocular and note whether a tubular structure characteristic of chrysotile asbestos is present. Switch into SAED mode and observe the diffraction pattern. Note whether the pattern is typical of chrysotile or amphibole, or whether it is ambiguous or neither chrysotile nor amphibole.

Count 100 fibers in several grid openings, or alternatively, count all fibers in at least 10 grid openings. If more than 300 fibers are observed in one grid opening, then a more lightly loaded filter sample should be used. If no other filter sample can be obtained, the available sample should be transferred onto a 400 mesh grid. Processing of the sample using ashing and sonification techniques should be avoided wherever possible.

Fiber number concentration is calculated from the following equations

$$\text{Fibers/m}^3 = \frac{\text{Total No. of Fibers}}{\text{No. of EM Fields}} \cdot \frac{\text{Total Effective Filter Area, cm}^2}{\text{Area of an EM Field, cm}^2} \cdot \frac{1}{\text{Volume of Air Sampled, m}^3}$$

Fiber mass for each type of asbestos in the sample is calculated by assuming that the breadth measurement is a diameter; thus, the mass can be calculated from

$$\text{Mass (ug)} = \frac{\pi}{4} \cdot (\text{length, um}) \cdot (\text{diameter, um})^2 \cdot (\text{density, g/cm}^3) \cdot 10^{-6}$$

The density of chrysotile is assumed to be 2.6 g/cm^3, and of amphibole 3.0 g/cm^3. The mass concentration for each type of asbestos is then calculated from

$$\text{Mass Concentration (ug/m}^3\text{) of a Particular Type} = \frac{\text{Total Mass of all Fibers of that Type (ug)}}{\text{Volume of Air Sampled (m}^3\text{)}}$$

Other characterizing parameters of the asbestos fibers are:

(a) Length and width distributions of chrysotile fibers
(b) Volume distribution of chrysotile fibers
(c) Fiber concentration of other asbestos minerals
(d) Relative proportion of chrysotile fibers with respect to total number of fibers. (from text)

Stewart, I.M.

Asbestos in the Water Supplies of the Ten Regional Cities. Part I.

Performing Organization:
Walter C. McCrone Associates, Inc.
Chicago, Illinois
Sponsoring Organization:
Office of Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C.
EPA-560/6-76-0]7, (NTIS #PB-252 620/0ST) 60 p. April]976

The Office of Toxic Substances of the Environmental Protection Agency has sponsored a nationwide survey to determine the impact of point and non-point sources on waterborne sources of asbestos. This survey covers both natural sites, in which asbestos-containing rocks are prevalent, and man-made sources (plants producing asbestos-containing products). Additionally, it provides for sampling water supplies in a number of cities and towns. This report records the results of the analyses of water from the ten cities housing Regional Headquarters of the Environmental Protection Agency. These cities are: Boston, Mass.,- New York, New York,- Philadelphia, Pa., - Atlanta, Ga., - Chicago, Ill., - Dallas, Texas, - Kansas City, Missouri, - Denver, Colorado, - San Francisco, California, and Seattle, Washington. The determination of asbestos content was by a transmission electron microscopic method.

Stewart, I.M.; Putscher, R.E.; Humecki, H.J.; Shimps, R.J.
Asbestos Fibers in Natural Runoff and Discharges from Sources Manufacuring Asbestos Products. Part II. Non-Point Sources and Point Sources Manufacturing Asbestos Products.

Performing Organization:
Walter C. McCrone Associates, Inc.
Chicago, Illinois
Sponsoring Organization:
Office of Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C.
EPA-560/6-76-020, (NTIS #PB-263 746/0ST) 175 p. October 1976

The Office of Toxic Substances of the Environmental Protection Agency has sponsored a nationwide survey to determine the impact of point and non-point sources on levels of waterborne asbestos. Part I of the final report presented the results of analyses of water from the ten Regional cities. Part II of the final report, contained herein, presents the results of the analyses of water from natural sources and from point sources manufacturing asbestos products. The results described indicate that waterborne levels of asbestos originating from natural sources may be as high as 10 to the 8th power fibers per liter and is subject to seasonal variation. Where asbestos was found, fibers were usually below 5 micrometers in length. Levels of asbestos originating from asbestos product manufacture may range from below the detection limits of electron microscopy to values in excess of 10 to the 12th power fibers per liter. Levels of asbestos fibers above 5 micrometers in length were found in excess of 10 to the 11th power fibers per liter. The major impact on the environment due to such sources would be expected from asbestos paper plants which combine a high fiber content with a large effluent flow.

Stewart, I.M.; Putscher, R.E.; Humecki, H.J.; Shimps, R.J.
Asbestos Fibers in Discharges from Selected Mining and Milling Activites. Part III.
Performing Organization:
Walter C. McCrone Associates, Inc.
Chicago, Illinois
Sponsoring Organization:
Office of Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C.
EPA-560/6-77-001, (NTIS #PB-264 288/2ST) 50 p. January 1977

The Office of Toxic Substances of the Environmental Protection Agency has sponsored a nationwide survey to determine the impact of point and non-point sources on levels of waterborne asbestos. Part I of the final report presented the results of analyses of water from the ten Regional cities. Part II of the final report presented the results of the analyses of water from natural sources and from point sources manufacturing asbestos products. Part III of the final report, contained herein, presents the results of the analyses of water from point sources associated with the mining and milling of potentially asbestos-bearing rocks. The results of these analyses indicate that a variety of mineral ore types may have asbestos minerals associated with them and that these fibers are liberated into their effluents. In some instances, however, the final effluent has little impact on levels in the local surface water which already have high asbestos contents.

"Drinking Water and Health: Recommendations of the National Academy of Sciences"
Sponsoring Organization:
U.S. Environmental Protection Agency
Washington, D.C.
Federal Register, 42(132):35763-35779 1979

A summary of a NAS report recommending maximum contaminant levels for substances in drinking water which may have adverse effects on humans is presented. Principles which underlie efforts to assess the irreversible effects of long-continued exposure to carcinogenic substances are outlined. Some recommendations for future research include a survey of suspended particulate matter in raw and treated drinking water, ingestion studies of fibers of various types and sizes in validated animal model systems, epidemiological studies of the trends in death rates in areas of high-fiber-concentration water, electron microscopy procedures for detecting and counting asbestos fibers, effects of organic, inorganic, and biological toxicants adsorbed on clay and organic particulates, and development of improved and standardized methods for determining particle concentrations and size distribution by optical techniques. Tables are presented which show the categories of known or suspected organic chemical carcinogens found in drinking water, organic pesticides and other organic contaminants in drinking water, organic pesticides and other organic contaminants found in drinking water with insufficient data on chronic toxicity, and organic contaminants found in drinking water on which information on chronic toxicity is lacking. (from Text)